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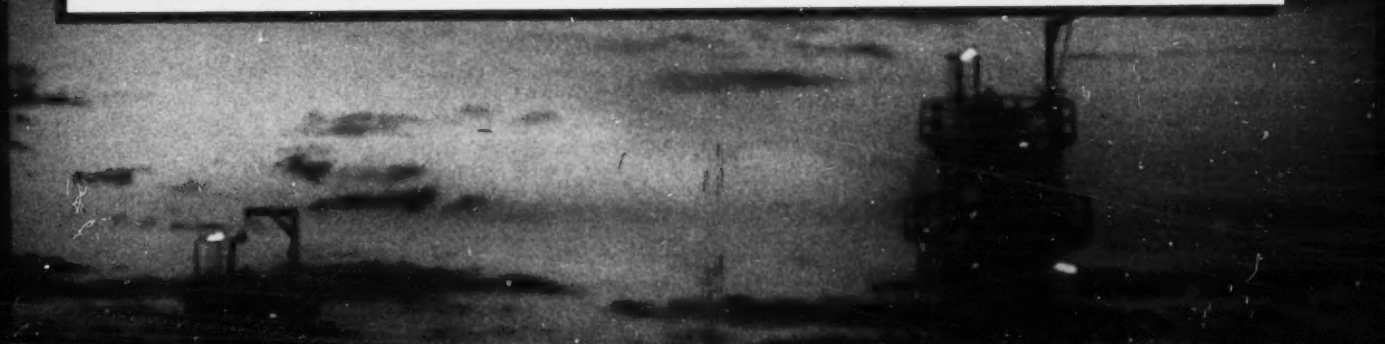
CHEMICAL & ENGINEERING NEWS

C&EN

AUGUST 3, 1992

CARBON FIBERS, HURT BY MILITARY CUTBACK, SEEK NEW MARKETS PAGE 16



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NATURAL GAS

rowing importance in Asia as fuel and feedstock

Page 7

CHEMICAL & ENGINEERING NEWS

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AUGUST 3, 1992

NEWS OF THE WEEK

■ In landmark fair use decision, a federal district court judge rules that photocopying copyrighted scientific materials requires compensation to journal publishers. Page 4

■ New process that encapsulates natural insect or synthetic pesticides with mixture of starch and dispersants makes pesticides less likely to evaporate or wash off plants. Page 5

■ Surveys by two environmental groups show that tracking toxic emissions of industrial plants outside the U.S. may be difficult unless countries enact right-to-know laws. Page 6

■ U.S. and Japan launch Geotail spacecraft on a four-year mission to explore Earth's magnetosphere. Page 6

COVER: Process area of Southeast Asian liquefied natural gas facility. Photo courtesy of M. W. Kellogg Co.

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U.S.-Russian cooperation in science and technology-related areas has been spurred by recent visits of several U.S. delegations to Russia. Page 26

New reagent that traps nitric acid is likely to have an impact on both environmental chemistry and medical research. Page 27

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LETTERS

Gene patenting

In the article "Critics Take Aim at NIH's Gene Patenting Strategy" (C&EN, June 8, page 21), the critics appear to be speaking from a standpoint of ignorance of the patent system. The simple fact is that the National Institutes of Health, by obtaining patents on expressed sequence tags (ESTs), will be able to effect whatever policy it ultimately determines is the best for the public good. Absent NIH's patenting strategy, the risk increases that private (and perhaps foreign) concerns will control patent rights, and that those concerns, not the government, will be in the position to edict under what terms and conditions the fundamental technology can be used.

Let's review the implications of NIH's applying for and obtaining patents. First, NIH has absolute discretion to determine what it wishes to do with its patent rights. NIH may dedicate those rights to the public or exclusively or nonexclusively license the patents to further developers (with or without royalty payments).

Second, the patent applications filed by NIH, upon becoming patents, constitute part of the prior art as of the date that they were filed. Thus, inventions of others must be novel and unobvious over the disclosure in the NIH patent applications. As those familiar with patents recognize, a patent disclosure is unlike a reviewed paper in a scientific journal. The inventor is legally required to make an enabling disclosure and reveal the best mode. But also in crafting a competing legal document, the inventor is wise to disclose the outer reaches of the scope of the invention. Even if not scientifically proven, information that the inventor believes to be true is legally acceptable in patent applications. This unproven information, not typically presented in technical papers, also becomes part of the prior art over which others must hurdle in order to obtain a patent. Thus, the patent application can be a much more effective document than a technical paper in preventing others from obtaining patents.

Third, seeking patents does not necessarily inhibit the exchange of technical information. A major reason not to disclose information about an invention prior to filing a patent application is that the recipient of the information may use it to seek patents on related inventions. Thus, whether or not it has a policy of seeking patents, NIH needs to reflect upon the extent of open exchange of information that it finds desirable.

In conclusion, the well-intentioned critics of the NIH patenting strategy, should they prevail, may find their position leading to exactly the result that they wish to avoid: Patent owners having exclusivity in the field of EST technology. The patent will be owned only by private entities, not by the government. The patent system, as it now exists, provides a tool that, if used benevolently by NIH, can maximize benefit to society for the emerging EST technology. I encourage James Watson and other opponents of the NIH patenting strategy to focus on what is best for society as a whole and not on the mechanisms for achieving that benefit.

Norman L. Balmer
Danbury, Conn.

Mo cumylcarbene catalyst

I wish to correct a statement in the Science/Technology Concentrates section concerning the formation of cyclic ethers by olefin metathesis (C&EN, June 29, page 26). The article states that a "commercially available molybdenum cumylcarbene catalyst" was employed. The catalyst, an $OCCH_3(CF_3)_2$ derivative, which was designed and synthesized in my laboratory, unfortunately is, to my knowledge, not commercially available. The $OC(CH_3)_3$ derivative is expected to be available soon from Strem Chemicals. Those who would like to explore the possibility of obtaining samples of the $OCCH_3(CF_3)_2$ derivative should contact David Hamm at Catalytica Associates, Mountain View, Calif., or prepare a sample by a newly published, relatively straightforward procedure [H. H. Fox et al., *Inorg. Chem.* **31,** 2287 (1992)].

Richard R. Schrock
Frederick G. Keyes Professor of Chemistry
Massachusetts Institute of Technology
Cambridge, Mass.

'Quasifood'

The Product Report by Ann M. Thayer (C&EN, June 15, page 26) is excellent, except for the title, "Food Additives."

"Quasifood" is far better than the old saw devoid of meaning. As a prefix, "quasi" means "having the characteristics of or certain of the qualities of"—to name but a few. So, let's drop the word "additives."

Jack DeMent
Portland, Ore.

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Natural gas offers industrial growth opportunities to developing nations

A usual assumption by economic planners and analysts is that the ready availability of fossil fuels, especially in developed countries, is the driving force behind industrial growth. It is further assumed that the developing countries of the world will develop similarly, if they have the requisite energy. A developing country is defined by the World Bank as one with a per capita gross national product of $5999 or less.

Detailed analyses of reserves and consumption indicate developing countries have about 40% of the world's natural gas reserves and 60% of the world's oil reserves. However, according to Donald L. Klass, retired vice president of the Institute of Gas Technology in Chicago, development and domestic use of these reserves has occurred in only 10 such countries: Algeria, Argentina, China, Hungary, Indonesia, Iran, Mexico, Pakistan, Poland, and Venezuela.

Even where gas reserves may be small by world standards, they are usually rather large for the domestic markets they could serve. The implication is that these gas reserves might be used well by domestic markets.

Although the bulk of the natural gas reserves are located in oil-exporting countries, significant gas reserves also exist in 30 developing countries that import oil. Thus, Klass says, there are substantial opportunities for developing countries to benefit from domestic gas reserves.

The expansion of natural gas use in these countries has often been the result of government policies rather than grass-roots entrepreneurship. The main reason for such expansion is to permit development of energy-intensive industries, which are the basis for economic growth—for example, steel, petrochemicals, and fertilizers. And although natural gas lately has become a frequent fuel of choice for the generation of electric power, the lack of a transportation and distribution infrastructure for natural gas has impeded its greater use.

Natural gas is primarily a fuel or a raw material. Its use as a fuel is familiar in most developed countries. In developing countries that decide to exploit domestic gas reserves, electric power generation is frequently the first large-scale application of this resource. Natural gas also is used in conversions and retrofitting of conventional boilers, as add-on generating capacity (especially for cofiring applications), and as afterburners for stack-gas cleanup. Where gas is used directly to power turbines the efficiencies are impressive. Power-only plants may sometimes operate above 50% total thermal efficiency. Combined-cycle operation gives lower but equally impressive efficiencies.

In recent years, natural gas has also assumed a new identity in developing countries—as a major chemical feedstock used in place of naphtha or fuel oil to manufacture a variety of chemical intermediates. The most notable examples of natural-gas-derived chemicals include carbon blacks, hydrogen, synthesis gas, methanol, ammonia, urea, and other nitrogen fertilizers.

The carbon blacks are made by thermal cracking. Synthesis gas and hydrogen are produced by partial oxidation and/or steam reforming. (In many developed countries, hydrogen is usually made by catalytic steam reforming rather than by partial oxidation.) Methanol is made by catalytic reduction of the carbon monoxide in synthesis gas. Ammonia is made by catalytic conversion of synthesis gas, and urea by the reaction of ammonia and carbon dioxide to form an intermediate ammonium carbamate that is subsequently dehydrated to produce the urea.

Liquids associated with natural gas are separated in wellhead gas processing plants. These liquids are mostly C_2 to C_4 hydrocarbons and can be used as sources for ethylene, propylene, and butylenes, which may be converted further to plastics and fuel additives such as methyl *tert*-butyl ether. Olefin yields from associated liquids are usually higher than the corresponding yields from steam cracking of naphthas and gas oils.

Klass cites the convenience of natural gas as an advantage in its use in steel and foundry applications. Except in blast furnaces, where coke is required as a chemical reductant, natural gas can often be substituted for coal and coke. And in metallurgical heat-

for heating homes and offices, because of the year-round warm climate. Use of air-conditioning, on the other hand, is expected to grow. The only household use of gas is for cooking, but this demand may remain satisfied by the use of liquefied petroleum gas, kerosene, and charcoal, depending on the income level of the consumer.

Nevertheless, however welcome rapid exploitation of natural gas might be economically, from an environmental point of view, it may be a mixed blessing. Some concerns in this regard were voiced at the Kuala Lumpur conference by Hirofumi Kataoka, executive vice president of Tokyo Gas Co.

Kataoka observes that although natural gas may be easier to live with than coal or oil, the real problem lies in consumption of fossil fuels in general. He repeats the litany of problems that have become familiar: global warming, depletion of tropical forests, ozone layer depletion, acid rain, desert expansion, marine contamination, extinction of species, transport of toxic wastes, and the growth of environmental pollution in developing countries.

From the viewpoint of the energy industry, Kataoka says, the most pressing problems are global warming, ozone layer depletion, acid rain, and environmental pollution in developing countries. These are the direct result of human activity in using energy to achieve rapid economic growth. Though pollution sources may be local, they have global effects and can last for generations.

The chemical and physical mechanisms at work in the environment are now well understood. But, Kataoka says, "if we wait until everything is scientifically understood, it may be too late." Ways must be found to minimize the impact of economic growth on the environment. If it isn't done, he says, the world may face dire consequences after 2000.

One of the nagging questions about natural gas is its future availability. Kataoka believes there will be sufficient gas available in the future. Known gas reserves are roughly equivalent to about 80% of known oil reserves, and the reserves-to-production ratio is higher than for oil. Prospects are particularly good in Asia. A major problem will be financing massive transportation and distribution systems.

To best use natural gas, Kataoka points out, a new com-

treating applications, where electrical heating is used primarily, natural gas is making some inroads.

In nearly every case where it is used, natural gas provides environmental benefits. In nonferrous metals industries, for example, a range of gas-fired equipment is being used for such things as processing of bauxite and in kiln operations.

In most of the developing countries, use of natural gas in space heating is minor, usually because climates are warm. However, there is a growing demand for air-conditioning in such nations. Where use of natural gas is increasing, it is often at the expense of oil's use.

Consumption of natural gas as a chemical feedstock has risen from less than 66,000 barrels of oil equivalent (BOE; 1 BOE = 5.8 million Btu) in Africa in 1975 to about 30 million BOE in 1988. Most of this increase has been because of investment in gas-fired equipment in Libya, which accounts for 67% of Africa's gas-based chemical production. A similar, if less pronounced, trend has been noted in Algeria, Egypt, and Tunisia.

In Latin America, use of natural gas as a chemical feedstock has been growing since the early 1970s. About 17% of Latin America's chemical feedstocks are natural gas. Most of that is consumed in Mexico, where the chemical industry is the second greatest consumer of natural gas after the energy sector. Natural gas is also a major feedstock in Venezuela, Trinidad and Tobago, Colombia, and Chile.

Natural gas feedstocks in Asia have risen to about 79 million BOE in the past 15 years. The chemical industry is now the largest consumer of the gas and accounts for 30% of all regional gas consumption.

In the Middle East, gas consumption in chemical plants has been about 42 million BOE, or about 10% of total gas consumption. Most is used for generating electric power and for other industrial fuel uses. Iran, the largest consumer of natural gas in the Middle East, uses none as chemical feedstock.

As far as defining trends is concerned, Klass observes, a key factor seems to be the ratio of gas reserves to production. Where high, there is a good chance that developing nations will be able to industrialize rapidly.

Use of natural gas in developing countries varies

Country	Natural gas use, quads[a]	Total energy use, quads	Natural gas		BOE[c] per capita
			% of total	R/P[b]	
Algeria	0.70	1.64	42.7%	72	4.48
Argentina	0.81	1.71	47.3	33	9.28
Brazil	0.11	3.27	3.4	36	3.82
China	0.52	24.79	2.1	68	3.88
Egypt	0.25	1.06	23.6	52	3.58
Hungary	0.42	1.07	39.3	—	17.6
India	0.32	7.14	4.5	57	1.47
Indonesia	0.49	1.38	35.5	66	1.31
Iran	0.73	2.27	32.2	703	7.29
Malaysia	0.30	0.67	44.8	100	6.60
Mexico	0.96	4.07	23.6	55	8.09
Nigeria	0.14	0.56	25.0	652	0.92
Pakistan	0.46	0.88	52.2	43	1.28
Poland	0.50	4.81	10.4	—	21.7
Thailand	0.19	0.97	19.6	28	3.05
Venezuela	0.63	1.51	41.7	123	13.5

a 1 quad = 10^{15} Btu. b R/P = reserve-to-production ratio (proved reserves divided by production). c BOE (barrel of oil equivalent) = 5.8×10^6 Btu. Source: Institute of Gas Technology

mitment to research and development, especially into ways to reduce emissions of sulfur and nitrogen oxides and carbon dioxide, will need to be made. Also, cogeneration should be promoted, and natural-gas-powered vehicles should be developed. The transfer of technology will require more international cooperation than now exists, he says, and developed countries must lead the way.

But Kataoka says he is not optimistic about the future. "Gas doesn't really offer us a solution to our problems," he observes. "It does offer an alternative problem that may be less onerous to solve."

The growing dependence of Japan on natural gas was underscored at the conference by K. Ukeda, executive vice president of Osaka Gas Co. He points out that total Japanese imports of LNG will reach 10 million metric tons by 1995. Like other Asian countries, Japan views the greater use of natural gas as a way to decrease its dependence on imported oil.

Ukeda also foresees expansion of natural gas use throughout Asia, leading to new chemical industries, particularly for fertilizer, methanol, and olefins. And he notes growing interest in natural gas fuel cells to generate electric power.

Malaysia is not the only Asian country to react to the oil pricing crises of the 1970s. Since 1979, the South Korean government has also diversified its energy resources as much as possible to provide stability against future vagaries in crude-oil pricing. The first response, like that of Japan's, was to import LNG, preferably from Asian sources. This drastically reduced the use of briquettes for home heating and cooking and, in the process, reduced local pollution levels.

According to Kwang-Jin Kim, deputy general manager of the project development department for Korea Gas Corp., Seoul is the main consuming area for LNG and has constructed major LNG facilities. LNG has all but replaced town gas, a mixture of coal gas and carbureted water gas, that was formerly supplied by Korea Gas.

Kim says in the near future, Korean demand for energy is expected to increase at an annual rate of 4.6%, and the demand for natural gas will be even higher at 10.4%. In the